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A COMPARISON OF THE SOCIOECONOMIC IMPACTS OF INTERNATIONAL FUEL SERVICE CENTERS VERSUS DISPERSED NUCLEAR FACILITIES

By: Robert B. Braid, Jr.

Energy Division
Oak Ridge National Laboratory*
Oak Ridge, Tennessee 37830

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AUTOBIOGRAPHY

Robert B. Braid, Jr., a research associate at Oak Ridge National Laboratory, analyzes the socioeconomic impacts of energy facilities for the Department of Energy and the Nuclear Regulatory Commission. Much of his work is associated with the licensing of nuclear power plants. Prior to joining the Laboratory he served as advisor to local governments in the Knoxville—Oak Ridge, Tennessee, area regarding the public service impacts of the Clinch River Breeder Reactor and was Chairman of the Department of Political Science at Maryville College. Dr. Braid received the Ph.D. in political science from the University of Tennessee in 1970.

ABSTRACT†

One of the most important issues in the National debate over nuclear power centers on proliferation. In April 1977, President Carter focused the Nation's attention on this issue by stating his opposition to the Clinch River Breeder Reactor. At his direction, various federal and private organizations have undertaken extensive investigations of the many aspects of the proliferation question with the objective of determining those reactors and fuel cycles which are most resistant to nuclear weapons proliferation.

The mode of siting nuclear power facilities is one factor which has received the attention of knowledgeable people both inside and outside of government. Considerable belief exists that the present policy of dispersing such facilities as the reactor, reprocessing, refabrication, and nuclear waste storate units among many sites constitutes an insufficient barrier to proliferation. An alternative to the present siting policy would be to colocate the various components of the nuclear fuel cycle at a single very large complex known as an International Fuel Service Center (IFSC). Regardless of the potential nonproliferation benefits of this proposed method of siting, the potential socioeconomic impacts such a facility could have on surrounding communities must be considered. A comparative socioeconomic analysis is essential if policy makers and the public are to be provided an adequate basis for formulating their decisions relative to the most appropriate mode for siting.

This paper investigates a variety of community impacts including: public services, fiscal issues, economic matters, land and water use, political and social cohesion, and legal considerations. Comparisons of socioeconomic impacts of colocated versus dispersed sites are made on the basis of the size of the impacted communities, the size and type of nuclear facility, and the facility's construction time frame. The paper concludes that, under similar circumstances, most of the socioeconomic impacts of colocated nuclear facilities would be somewhat less than the sum of the impacts associated with equivalent dispersed sites. While empirical data is non-existent, the paper contends, however, that because the socioeconomic impacts of colocated facilities are so great and readily identifiable to a public unskilled in making comparisons with the dispersed alternative, the facilities will likely generate so much public opposition that IFSCs will probably prove infeasible.

Introduction

Proliferation is one of the most important issues in the debate over nuclear power centers. In April 1977, President Carter focused the Nation's attention on this issue by stating his opposition to the Clinch River Breeder Reactor. At his direction, various federal and private organizations have undertaken extensive investigations of the many aspects of proliferation with the objective of determining the most effective measures for reducing the spread of weapons technology and the accessibility of plutonium, which could be used to fabricate weapons. This paper is the outgrowth of one phase of these investigations.

One means of reducing proliferation danger which has received attention from knowledgeable people both inside and outside of government involves a change in the siting mode of nuclear power facilities. There is considerable consensus that the present policy of dispersing such facilities as the reactor, reprocessing, refabrication, and nuclear waste storate units among many sites constitutes an insufficient barrier to proliferation. An alternative to the present siting practice would be to colocate various components of the nuclear fuel cycle at a very large complex known as an International Fuel Service Center (IFSC). An as yet unspecified degree of multinational participation has been envisioned in these centers. The apparent objective is to create at least a measure of shared interest and involvement in all phases of the nuclear fuel cycle in an effort to discourage efforts by individual nations to establish and operate their own nuclear power facilities, particularly those which are nonpower portions of the fuel cycle (Cole, 1978).

Regardless of any nonproliferation benefits which could result from the colocation proposal, the socioeconomic impacts such a huge facility might have on surrounding communities cannot be ignored. A comparative socioeconomic analysis of colocated and dispersed siting modes is essential if policy makers and the public are to be provided an adequate basis for formulating decisions relative to the most appropriate type of siting.

The following analysis compares the IFSC both to a single two-unit generating plant and to its equivalent in dispersed generating plants or other fuel cycle facilities. Of necessity, the analysis must be generic and somewhat speculative because of the nonexistence of IFSCs or of reasonably equivalent colocated facilities from which actual or surrogate data could be used. The data base for this analysis originates with the light-water reactors (LWRs) operating and under construction at over 80 sites in the United States. The analysis also builds upon assessments of energy centers made by others in recent years.

Although the types of proposed IFSCs are rather diverse in terms of numbers and types of reactors and fuel cycle facilities, this paper examines primarily a power-generating center of 20 on-site reactors with reprocessing, refabrication, and long-term waste storage facilities and a non-power-generating center of only the last three components.

This assessment is confined to the United States since no additional candidate nations have been proposed as hosts for IFSCs.

Previous Studies

Several recent studies have investigated the potential advantages and disadvantages of proposed nuclear energy centers, which are physically similar to IFSCs. Many of the findings of these studies have been incorporated into the present assessment. Regarding any socioeconomic benefits of such centers over dispersed sites, the earlier analyses have had mixed results. The Nuclear Regulatory Commission (NRC) concluded that no compelling socioeconomic advantages were accrued to centers (NRC, 1976: I, 4–59). Battelle Memorial Institute arrived at different results in that it argued that fewer, more manageable impacts would occur at centers in the long run (Battelle, 1975: 95). General Electric Company concluded that energy parks (centers) could be bad for metropolitan areas by contributing to urban sprawl but good for rural areas by serving as the catalyst for community development (General Electric Co., 1975: II, 6–106, 6–107). No analysis has concluded that, from a socioeconomic standpoint, the present policy of dispersed siting is definitely superior to colocated facilities.

Major Facility Parameters Influencing the Comparison

Several important parameters regarding type, size, location, and construction schedule of the IFSC should be identified at this point. Significant differences in community impacts would be likely to occur based upon these parameters.

The fact that an IFSC is a power-generating or non-power-generating facility could have a bearing on community impacts. The essential difference is that construction labor force requirements of facilities with generating plants would be at least ten times the size of their operating forces, while non-generating facilities would require a more even distribution of manpower between the two phases.

A second, closely related factor would be the time schedule for initiating construction of each reactor. A compression or expansion of this schedule would affect the work force requirements and, consequently, the magnitude of the great majority of impacts on local communities.

A third factor would be the size of the colocated facility as determined by number of reactors and types of fuel cycle facilities. A wide variety of IFSCs have been envisioned, but the diversity in size need not always result in a corresponding difference in community impacts, either from one another of their dispersed alternatives. This paper focuses essentially on a 20-reactor IFSC, but comparisons will sometimes be made to other sizes to illustrate a point.

The final consideration is whether the IFSC is to be sited in an essentially semiurban area or in an isolated rural region. The corresponding presence or absence of existing private and public infrastructures would play an important part in determining the nature and degree of socioeconomic impacts.

Work Force Requirements

A particularly crucial determinant of community impacts for any nuclear facility is its construction and operation work force requirements. More specifically, most community impacts are dependent upon the number of inmigrant workers employed at the facility, because they and their dependents create the additional burdens on the private and public infrastructures of local communities.

The peak construction force projections have ranged from a low of 4000 for a non-power IFSC (NRC, 1976: IV, 2–15) to a high of 20,800 for a 40-reactor IFSC with a two-unit per year startup rate (Battelle, 1975: 4). Depending upon the other facility parameters, and using estimated employment multipliers of 1.2 for relatively developed areas and 2.25 for underdeveloped areas and an average family size of 2.8 (allowing for both married and unmarried workers), direct and indirect population related to an IFSC would thus range from 13,440 to 131,040 during the peak period of construction. For a 20-reactor IFSC and associated fuel cycle facilities and a one-reactor per year startup rate — the size and construction schedule assumed essentially for this report — the peak construction force would amount to 10,200 (NRC, 1976: IV, 5–16) and the total direct and indirect population would be between 34,272 and 64,260. The portion of these individuals who would inmigrate depends on factors discussed below. As is apparent, the wide variance in population totals makes precise estimates for a generic IFSC impossible; numerous site-specific factors have too great a bearing on ultimate totals. Operating force levels would be near the low end of the first range for non-power facilities but more indeterminant for power-generating facilities because of several intervening variables.

An important caveat in such population estimates is the fact that both construction and operation manpower requirements have been escalating dramatically each year. Research in progress by the author at Oak Ridge National Laboratory indicates that a typical two-unit LWR plant requires approximately 4,000 workers at peak of construction and 250 during operation. Such totals suggest that the ranges of employment and population indicated above may be on the low side, but the precise degree of underestimating has not been established at this point.

Region Impacted

Another important determinant of socioeconomic impacts is the nature of the region affected by the energy facility. Experience from current nuclear plants (Purdy et al., 1977, and Shields et al., 1979) and western primarily coal-related projects (Gilmore 1975, 1976 and Old West Regional Commission, 1975) indicates a fairly substantial inverse correlation between the size of the communities within commuting distance of the project and the level of impact they experience. Small, isolated rural communities typically are impacted most, whereas more urbanized regions are impacted least.

Determination of these impacts involves a combination of factors. Obviously, the fixed number of construction or operations workers needed at the facility would constitute a much higher percentage of a smaller community than a larger more urbanized one. In addition, larger communities could supply a far greater number of workers than the smaller communities, thus reducing the level of inmigration. The generally less developed private and public infrastructure existing in smaller communities would likely be faced with very burdensome problems in trying to respond to the service needs of the new residents, as opposed to the infrastructures of larger communities in which the smaller influx — both relatively and absolutely — of new residents could be handled. A final aspect to be considered is the level of commuting. Small communities beyond commuting distance of large labor sheds would experience greater inmigration than would communities within easy commuting distance.

The size and location of the community impacted apparently play a significant role in determining the degree of energy facility impacts. With a huge complex such as an IFSC, smaller, more isolated communities would be placed at a particular disadvantage compared to more urbanized areas. Although developed communities appear to offer certain distinct initial advantages over undeveloped areas as sites for IFSCs, several significant potential problems could intrude. These include radiation dose limitations of the Nuclear Regulatory Commission (10 CFR 100), the location of load centers, and the difficulty of putting together a very large tract of land with water availability. Ultimately, only a site-specific assessment could resolve these questions.

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Public Service Impacts

A key matter of concern in assessing socioeconomic impacts of large energy facilities is their effect on public services supplied by local governments. Closely associated with the delivery of public services is the generation of revenue to pay for them, a vital factor which receives considerable attention in the succeeding section. Two types of potential service impacts can be identified. One type is the more substantial impact typically associated with smaller, isolated communities which are required to construct new public facilities and to offer a much greater variety of services than previously supplied. Examples of such impacted communities include Uinta and Sweetwater counties in Wyoming, impacted by numerous energy facilities (NACo., 1976); Wheatland, Wyoming, site of a major coal mine and generating plant; and Hartsville, Tennessee, the location for a four-unit TVA nuclear plant. The other type is the more modest or subtle impact associated with larger communities or more developed, densely populated commuting regions where new facilities need not be constructed, but operational effectiveness requires incremental increases in funds, vehicles, and personnel in order to avoid dilution of services such as crowded classrooms, slower police response rates, or less frequent garbage pickup. Examples of these impacts would be associated with nuclear generating plants in Massachusetts (Pilgrim), Wisconsin (Point Beach), New Jersey (Salem), and Maryland (Calvert Cliffs).

The considerably greater expense of providing adequate public services in the smaller communities points to the importance of the population size of the existing community, as discussed earlier. Although nuclear generating facilities have normally been sited in more developed areas, thus reducing their adverse impacts on surrounding communities, this practice might not prevail with IFSCs although the public service advantages of such siting would be quite significant. Public service impacts would also be affected by the number of reactors in the IFSC, the construction rate of reactors, and the type of non-generating fuel cycle components. Each characteristic dramatically affects manpower requirements and, consequently, community impacts.

The conclusion appears inescapable that an IFSC would have far greater public service impacts than a two-unit LWR sited in the same location, but such a conclusion should by no means automatically result in a negative assessment of the colocation approach. For example, Garvey (General Electric, 1976) has suggested siting IFSCs in rural areas to serve as massive "growth poles" for regional development. Such centers would stimulate redistribution of the population and require the development of entirely new, but thoroughly planned, communities with associated services. Because of their smaller size, two-unit nuclear plants are at best stimulators of local growth and could not create the impetus for regional growth envisioned by Garvey. While Garvey might be more enamored than most of the social engineering possibilities implicit in such a regional growth pole approach, it is evident that if IFSCs were sited in remote areas, the need would exist either to enlarge greatly any existing rural communities or to construct one or more towns of appreciable size in order to support the construction and operation of the facility. The permanent or near-permanent length of the construction period for a power-generating IFSC of many reactors should help to mitigate a number of potentially adverse impacts on surrounding communities. If the construction startups for the reactors were phased properly, the first unit could be decommissioned as its replacement unit became operational. This phased replacement of reactors could thus create a permanent rather than a temporary construction force. Not only would certain economies result from the construction process itself, but the local communities could plan permanent facilities and services. The currently haphazard, often submarginal, measures taken by local governments to accommodate new residents, whose temporary presence does not justify large capital expenditures, could be replaced by responsible growth management designed to ensure attractive permanent communities with adequate services. Not only could higher quality services be offered, but a wider range of services could be supplied to residents through the virtually permanent construction process at the IFSC.

It should be indicated at this point that this long-term growth advantage would generally be associated only with the larger power-generating IFSCs rather than smaller centers of six to ten reactors unless anticipated construction schedules were radically altered. In the small center situation, the construction force would be on site for a number of years but, with no ensuing facilities to construct, would ultimately be disbanded. Thus, the longer but still temporary nature of the impacts presently associated with dispersed nuclear power plants would still occur with the smaller power-generating IFSCs. Non-power-generating IFSCs, with substantially equivalent construction and operations work forces, would permit better funding and planning of local services than dispersed power-generating units or smaller power-generating IFSCs. No other appreciable differences should occur relative to dispersed, non-power fuel cycle facilities except for the somewhat larger magnitude of the impacts resulting from the center.

The primary public service advantage for IFSCs would appear to be found in comparison to the collective impacts associated with an equivalent number of dispersed reactors and fuel cycle facilities at as many as 10 or 12 similar locations. There are several reasons for the projected advantages of the center alternative. Certain economies should occur in the construction of facilities for the aggregated population in this alternative that would not occur in the construction of multiple facilities needed to provide similar services for the dispersed site populations. A similar conclusion should hold in the provision of public services for the aggregated population. The quality of services for IFSC workers should also be higher than for those at dispersed sites because of the greater permanence of the facilities, the likelihood of more effective growth management, efficiencies normally associated with certain economies of scale for medium-size communities as compared with smaller communities, and the probability that a greater variety of services would be extended to residents of IFSC communities. Although these benefits are speculative, they conform to generally accepted assumptions about the relationship between community size and public service capacities. Because of the greater permanence of the IFSC community, debt financing, while much greater, should be easier and less expensive than any financing that could be arranged by communities in the dispersed site scenario. It should be remembered also that projected construction manpower requirements for a center are somewhat less than for its equivalent in dispersed sites as a result of the use of less labor-intensive equipment, such as large overhead cranes, and greater efficiencies in utilization of labor in the construction of the center (General Electric 1976: II, 9–122 to 9–125). Consequently, the total population being provided services in the IFSC situation should be somewhat less than that in the combined dispersed site situation.

This savings in manpower for a power-generating IFSC would not appear to carry over to a non-power-generating IFSC. The reduced learning curve created by constructing successive reactors in the former IFSC would not operate in the latter case where duplication of facilities does not exist; consequently, manpower efficiencies from this source would not be expected at non-power IFSCs. In addition, any labor-saving construction techniques applicable at colocated non-power IFSCs should be suitable for dispersed sites also — again as a result of the unique nature of each facility at its site. The result of this situation is that population totals and thus public service impacts at a non-power IFSC community should approximate the sum of the populations of equivalent dispersed sites.

Any community public service benefits which could reasonably be expected from a non-power-generating IFSC and not from a dispersed facility would stem from the more efficient community planning. This planning should characterize the center alternative and the limited economies of scale, particularly in public facilities, which should be possible at the colocated site.

It seems apparent that in the area of public services, at least, while large colocated facilities offer the prospect of reducing somewhat the adverse impacts of dispersed siting, the benefits would be more noticeable with the power-generating type of IFSC than with the non-power-generating IFSC. An important qualification to this relatively favorable assessment of IFSCs is that the conclusions are tenable only where similar impact communities are being considered — a fact which may not occur in an actual construction/operation scenario. Any comparisons of IFSCs to dispersed sites in situations involving dissimilar communities is an entirely different matter which can be resolved only through a site-specific analysis.

Fiscal Impacts

The fiscal impacts which could easily result from the siting of an IFSC constitute some of the potentially most significant socioeconomic questions raised by such a center. In order to accommodate the possibly large population increase associated with an IFSC, substantial funds would have to be expended on services. Adequate funding would by no means be guaranteed but would be dependent upon resolution of several important questions.

One important issue is whether local jurisdictions would be able to retain property tax revenues from the IFSC. Existing privately owned nuclear power plants pay substantial property taxes, and the large majority of states permit their local governments to retain these revenues for their own use. Numerous taxation systems exist among the states, but the most important exception to local retention is for the state to require the redistribution of those property tax revenues among the jurisdictions of the entire state. Pennsylvania, Maine, and Wisconsin are prime examples of this statewide redistribution approach.

In the case of at least two states, it appears that the existence of one- or two-unit LWR plants was sufficient to help convince the state legislatures to redistribute the property tax revenues throughout the entire state. With the vastly greater revenues to be generated by a power-generating IFSC, the pressures within many states to redistribute such revenue bonanzas could be expected to gain much more impetus. This point would appear to be a primary and extremely important difference between dispersed and colocated power-generating facilities and, probably to a lesser extent, non-power-generating facilities if they were privately owned. In the case of Pennsylvania, the issue was so important that it played a leading role in keeping a nuclear energy center from being built in the state. Citizens of rural communities in which a nuclear energy center might have been sited looked with strong disfavor upon the project because Pennsylvania state law would have required the tax revenues to be not only redistributed throughout the state but done so in accordance with a formula designed to favor large urban areas. Analysts of this particular controversy concluded than an energy center in either

Pennsylvania or New Jersey — which maintained a non-redistributive tax system — would greatly exacerbate the current conflict between small areas and large cities on this sort of taxing issue. The ultimate conclusions of these analysts was that no state in the country utilizes a tax structure which could equitably accommodate a nuclear energy center because the tax systems are "archaic, antiquated and outmoded" (Farrar et al., 1976).

The fiscal impacts that appear likely with a taxable IFSC would seem to move the current debate over distribution of taxes to an even higher level of importance both quantitatively and jurisdictionally. With dispersed LWRs the fiscal issue has normally revolved around the well-recognized fact that a single community gains a tremendous addition to its tax base, whereas other jurisdictions in the area experience inmigration impacts but receive no property tax revenue from the plant to compensate for the additional burdens (Purdy et al., 1977 and Shields et al., 1979). This situation is the opposite of the Pennsylvania case and points to the inequities present at most nuclear plant sites where a state-established local monoply over the tax base prevents a sharing of tax revenues in accordance with the impacts created by a portion of that tax base. What might presently seem acceptable in most states with a nuclear plant paying from several million dollars in property taxes annually upward to possibly even ten times that amount — depending upon plant size and local assessment and tax rates — would undoubtedly be much less acceptable with facilities the size of IFSCs, which may conceivably pay hundreds of millions of dollars annually in property taxes (Bjornstad, 1976). The existing issue of significant but localized fiscal inequities would be replaced by much more serious considerations with IFSCs. The tax issue would unavoidably become a statewide issue with not only redistribution of the revenue a subject of debate but also the scheme of apportioning the revenue. If, indeed, state redistribution were decreed, would sufficient fiscal incentives be left to motivate any local communities to accept an energy center? In the seemingly unlikely event that all the property tax revenues were permitted to remain in the host community, a new problem could arise: How would the community, particularly if it were relatively small, spend the huge bonanza? As was demonstrated in the Pennsylvania study and in analyses of dispersed sites as well, these questions go to the heart of community impacts and the attitudes of community residents toward the center.

An additional issue of a fiscal nature often accompanies the construction of LWRs at dispersed sites. This issue is the delay in the acquisition of property tax revenues from the power plant which are needed to finance capital outlays for public services to plant employees. Although not every area impacted by a nuclear plant is so ill-equipped as to require the construction of new public facilities, it is a common need in smaller communities. The problem arises when the construction workers arrive long before the revenues required to finance services to those individuals. Various alternatives have been undertaken to resolve this problem, including loans guaranteed by the utility, prepayment of taxes, direct support payments by the utility, financial assistance from the state, or simply nothing until the money is in hand to pay for the facilities. Financial assistance plans developed by Puget Sound Power and

Light at its Skagit nuclear plant; the Tennessee Valley Authority at its Hartsville, Phipps Bend, and Yellow Creek nuclear plants; and the Missouri Basin Power Project for its coal-fired plant at Wheatland, Wyoming, are particularly useful examples of what steps can be taken.* While the problem would be similar with an IFSC, the amount of funds which would quite likely be required would be far greater. Given the possibility that isolated rural areas appear to be prime candidates for IFSCs, such communities would be even less equipped to handle the initial financial burdens posed by such centers than they would with a two-unit nuclear plant. It thus becomes even more imperative that standardized procedures be established to enable communities to resolve this public facilities dilemma. A situation in which inadequate facilities might be stretched to accommodate an LWR construction work force would not work for an IFSC; the numbers of workers and dependents involved would be simply too large. In addition, the near-permanent nature of the construction period at a 20-unit IFSC would make mandatory — yet much more feasible — the construction of adequate facilities to accommodate the workers.

The very sizable financial burdens for rural governments implicit in an energy center, coupled with the strong federal interest and near-monopoly over other phases of the fuel cycle, lend impetus to the possibility that IFSCs would serve to increase the role of the federal government in comparison to the part it plays in the siting of dispersed LWR plants (U.S. Nuclear Regulatory Commission, 1976). Any number of situations involving increased federal participation are readily foreseeable and have been discussed in energy center literature.

From the standpoint of impacted communities, federal ownership of the entire complex would likely be the worst alternative, sinch such a facility would not be taxable under the present law. Payments in lieu of taxes represent the solution offered by Congress in the past, but this approach has fallen into increasing disfavor and has had rather mixed and controversial results for recipient jurisdictions such as Oak Ridge, Tennessee, and Los Alamos, New Mexico. A more remote possibility would be for the federal government to provide funding to local governments equal to the taxes generated by a privately owned facility. Whereas the obvious fiscal burdens posed for host communities would seem to militate against federal ownership at least of power-generating facilities, the designation of such centers as "international" could well suggest such a substantial federal role.

Another prospect would be one in which only the land for the IFSC were federally owned. Because of the potential difficulty posed by competing uses in acquiring such a large bloc of land, estimated to be 1 acre per megawatt of electricity generated (Nuclear Regulatory Commission, 1976: I, 3-16), such an alternative could serve as a strong incentive for utilities to join an IFSC. Given this possibility, attention should undoubtedly be directed at an early date to the resulting tax obligations of the utilities. Conceivably, the utilities could purchase the land, and the IFSC would then be treated as any other taxable facility; or the federal government could permit use of the land with an agreement by the utilities to provide adequate payments to local jurisdictions. In either case, the magnitude of the impacts on local communities would be such that an adequate level of financing for local governments would be essential.

In addition to the types of federal financial involvement mentioned above, another alternative would be the possibility of federal participation in front-end funding of local public services. Because of the probable need in rural areas for substantial additions to facilities and the existing difficulty in securing such necessary front-end funds, it appears that IFSCs would create a greater need for federal assistance than would dispersed plants. Conceivably such assistance could be in the form of federal loans, grants, or guarantees on loans from other sources. Congress has been considering for some time legislation which would establish mechanisms for federal funding of efforts by communities to mitigate the impacts of energy development projects. Such legislation should be well suited to IFSCs.

It should be apparent from this discussion that the fiscal issues surrounding IFSCs would be very significant. Indeed, they would be among the most salient questions raised by the centers. The resolution of these issues would require considerably more concerted effort than has been directed at the more modest problems posed by dispersed facilities. Because of the great importance the public attaches to fiscal matters and, in turn, the crucial role which public opinion would have on the ultimate feasibility of international fuel service centers, it would be essential that an adequate and equitable taxation procedure be established early in the program.

Legal Impacts

The legal impacts which appear likely to accompany an IFSC would far exceed those associated with dispersed nuclear generating facilities. The potential for revisions of the tax laws at the federal, state, and local levels were examined in the previous section and will not be repeated here. There are, however, many additional issues which seem destined to be the sources of new laws at different levels of government or even between governments in the form of agreements or interstate compacts. Although existing laws in all these areas relate in some manner to dispersed facilities, such plants in themselves seldom created the impetus for the laws. However, it seems likely that IFSCs would generate new legislation as a result of the tremendous size of nuclear energy centers and their greater public visibility.

Antitrust law might well have to undergo revision in response to IFSCs. Although a detailed examination of existing legislation is beyond the scope of this paper, it is apparent that attention should be focused on the implication IFSCs might have for such legislation. It is not a foregone conclusion that current laws, which have been adequate to accommodate LWRs, would prove unable to cover the IFSC situation. Such a determination could be made only after a full investigation of such matters as access to an essential resource, vertical integration of utilities at an IFSC, joint ventures by competitors, concentration of market power, discriminatory dealings, and market allocation (Nuclear Regulatory Commission, 1976: IV, 4-20 to 4-23).

The issue of permanent storage of nuclear waste is well known and would certainly be raised to a more intense level of debate in the event of colocated power-generating facilities. Several states, including California and potentially New York, now prohibit the siting of additional nuclear power plants within their borders until the waste management problem is solved. The potential impact a 20-unit IFSC would have on this controversial subject should be apparent, and restrictive siting legislation on the part of many states would be a distinct possibility. Indeed, the successful resolution of the nuclear waste problem would appear to be a prerequisite to the siting of either power- or non-power-generating IFSCs.

Community development issues such as zoning, subdivision regulations, mobile home regulations, public health ordinances, and various forms of state assistance to local jurisdictions might well receive more legal attention in a state where an IFSC was to be sited. With the great potential for economic and community growth implicit in such a center and the more modest, yet recognized, growth impacts accompanying dispersed nuclear plants, local communities and the state itself would be forced to update growth management programs. Such a procedure could conceivably require changes in the laws regarding such functions. With the great size of an IFSC along with its high degree of public visibility, state and possibly even federal intervention in the community development process would quite probably mean a corresponding decrease in the degree of local autonomy over the planning and development processes in the impacted communities. Inevitably, the more widespread the changes in such communities, the greater would be the role played by outsiders in that growth.

Additional issues would likely give rise to new laws involving air and water uses and environmental matter in general. Problems already associated with LWRs, such as conversion of land to power production and transmission, water supply availability, air pollution, thermal effluents, aesthetic impairments, and climatic changes, appear more intense with energy centers (General Electric Company, 1975: I, ES-26).

It is impossible to assess at the prsent time whether the potential adverse impacts of a center to the natural environment would be less or greater than the collective impacts at the equivalent number of dispersed facilities. In regard to environmental pollution, at least one study suggests there may be advantages in the idea of "concentrate and contain" compared to the alternative of "dilute and disperse" (General Electric Co., 1975: I, ES-27). However, such a conclusion would be highly dependent upon site-specific data.

The availability of water for cooling purposes, which could constitute a significant barrier to siting, has received an unusual amount of attention in several studies of energy centers (Nuclear Regulatory Commission, 1976; Western Interstate Nuclear Board, 1978; Southern States Energy Board, 1978). A major concern is whether ample water would be available for both cooling the reactors at the IFSC and permitting the unimpeded growth of the non-IFSC activities in the region. Such concerns are particularly salient in the West, where a wide variety of intricate relationships govern the ultimate use of the regionally scarce but vital resource (General Electric Co., 1975: I, ES-27).

Heat rejection problems from the colocated reactors may be of such magnitude as to cause weather modifications not normally associated with dispersed facilities (General Electric Co., 1975: I, E-28 to E-29). Much is dependent upon site-specific factors, but the apparent potential for adverse community impacts could provide an impetus for state or national legislation.

All these potential adverse environmental impacts of IFSCs may generate demands for additional legislation, and any effort to construct IFSCs must recognize the possibility of restrictive legislation in these matters.

The effect of IFSC with a large number of reactors on utility rates or services is difficult to ascertain at this time. There is little evidence that the costs of colocated facilities would outweigh those for equivalent dispersed sites, thereby escalating consumer price increases for electricity, but it is possible that greater coordination of services to consumers would be required because of the huge generating capability of the center. Such coordination may well require the development of interstate compacts to govern transmission of power across state lines or may even entail more federal intervention through the Federal Energy Regulatory Commission.

It is evident from the foregoing discussion that IFSCs may well have a more significant impact on existing law than dispersed nuclear plants and that successful siting of an IFSC must anticipate possibly major changes in state and federal laws.

Political and Social Cohesion Impacts

It would certainly be an exaggeration to assume that the community upheavals depicted in recent western-oriented "boomtown" literature establish characteristic patterns for local political and social impacts from nuclear plants. However, such impacts can occur if the plant is sited in a particularly isolated area. Even in less remote communities where nuclear generating plants are typically located, subtle impacts of a political and social nature often do occur. Definitive research into these questions has yet to be undertaken, but the net effect often seems to be to introduce certain modernizing forces into the community which alter the preplant attitudes and culture. Recent studies of operating nuclear power plants indicate that land use, equity, and economic development issues, for example, are raised as a result of the presence of the plant (Purdy et al., 1977; Shields et al., 1979). Alterations in a community's way of life and the emergence of new community organizations and new leadership may also result from the plant's presence (U.S. Nuclear Regulatory Commission, IV, 1976).

It appears quite conceivable that an IFSC would offer certain opportunities for eliminating some of the adverse political and social impacts, particularly in heavily impacted communities. The provision of more and better services to residents in the vicinity of an IFSC compared to those at dispersed sites should be feasible, as was indicated earlier in this paper. Improved services should help mitigate some of the social problems which could otherwise be created by an IFSC in a "worst possible case" situation. Such problems would include increased juvenile delinquency, marital problems, alcoholism, poor housing, and boredom, all of which can contribute to the breakdown of community values and organization. The recognition that a facility as large as an IFSC could easily create such social problems at more isolated sites, coupled with the greater opportunities for designing and funding improved services in comparison to dispersed sites, should mark these social issues as ones which the center alternative could help mitigate.

The fact that only one region would be affected in the IFSC alternative rather than possibly ten areas in the dispersed situation should in itself make the IFSC alternative more attractive. The potential impact of an IFSC on a single region would certainly be greater than that of a two-unit plant, but even in this comparison, the IFSC may not be significantly worse. If an isolated region could be overwhelmed even by a two-unit plant, an IFSC probably could not make the damage much worse, although the extent of the region would be greater. Used as the prime engine for long-term economic growth and conceivably the causative factor for the development of a new, permanent community, the IFSC should be of such consequence as to force the recognition and resolution of many of the social problems currently experienced with smaller energy projects. In this respect, however, it should be recognized that an IFSC of this magnitude would be likely to dominate the smaller communities nearby and this, in itself, raises the specter of a "company town" — an image which is generally not thought of as particularly beneficial. Such dominance is not generally associated with two-unit LWR plants even during the construction period.

The severity of the impacts on local political and social infrastructures could be greatly reduced in the event that the IFSC were sited within commuting distance of one or more sizable urban areas. The larger communities would have a greater existence beyond that of the center itself, thus giving them greater stability and increased independence from the center. In addition, the level of inmigration and consequent adverse social impacts would be substantially reduced because more workers could commute to their jobs at the IFSC. Thus the actual location of an IFSC would play a major role in determining the impacts to the political and social cohesion of communities in the region and the mitigative measures that would have to be utilized. Another means of reducing the relative community influence of an IFSC would be location of unrelated industries in the impacted communities to act as balancing forces. Such a technique would be particularly useful in smaller communities, but the problems of attracting large competing industries must not be overlooked. It should be pointed out that no evidence appears to exist of such colocation by competing industries in existing nuclear host communities.

Even with the mitigative measures above, it is easy to foresee that an IFSC would have significant implications for the social order of any host community except one of great size. It is not simply the magnitude of the center which would produce changes. It is the new types of people with different interests, ideas, and social morés likely to move in and the consequent potential for conflicts implicit in the introduction of such new forces; the high visibility of the center; the multinational participation, with its potential for introducing a cosmopolitan atmosphere into the host community; and the strong growth impetus likely to be injected into the community due to the IFSC. The combination of all these factors would produce a seemingly inevitable new future for the host community. The recognition of such a prospect by the existing residents of the community might set forces in motion which would unalterably affect normal political and social patterns.

Economic Impacts

It is impossible to escape the conclusion that either a power- or non-power-generating IFSC would have a significant to profound economic impact on a host community. The range serves to distinguish the impacts on a relatively developed area at one extreme as opposed to an undeveloped area at the other. As with so many comparisons of the potential impacts of colocated facilities and dispersed sites, much is dependent upon the actual location.

It appears that the number of secondary jobs would be greater for an IFSC than for its equivalent in dispersed facilities. The reason for this conclusion is that the very long construction period and large operating manpower requirements of the IFSC would create the incentive for private companies as well as government agencies to hire new employees to service the needs of those directly employed at the center (Battelle Memorial Institute, 1975). Much of this incentive is currently nonexistent for the smaller one- or two-unit LWR 1000-MW(e) plants. This favorable situation would be particularly true for large power-generating IFSCs with extended construction time frames or for non-power-generating IFSCs with similar construction and operations work forces. It also appears likely that more secondary jobs would be created in isolated sites than in more developed communities. In the former case, virtually complete private and public infrastructures would have to be built to support a population of perhaps 50,000 or more. At IFSC sites within commuting distance of large urban communities, existing infrastructures would be in place. The greater dispersion of workers and the slack available in many current services should reduce the need for hiring additional employees in supporting positions.

One of the arguments presented in favor of colocating numerous reactors at a single center is the manpower savings for primary jobs. Such savings would not appear to be great, and from the standpoint of making impact projections on surrounding communities, are more than canceled out by difficulties in long-range forecasting, the continued escalation in manpower requirements, and the greater numbers of secondary jobs in smaller communities. Thus it would appear that any savings in direct or primary employement at the IFSC compared to dispersed sites would be relatively small and subject to being outweighed by other factors.

Income multipliers should not be as significantly affected as the employment multipliers in the comparisons between centers and dispersed plants. Typically, rural areas which must export many of their dollars for finished products will have lower income multipliers than more developed communities which can provide relatively more of those finished goods, thereby reducing the amount of money which leaves the community. This situation holds for existing LWRs, and little change seems probable for IFSCs. In essence, the impacts in each siting case should be similar relative to the proportion of dollars held within the impacted community. One exception, however, may lie in the possibility that communities hosting centers would experience more growth than the combined growth of equivalent dispersed sites. If such a scenario were to occur, it seems probable that the resulting community would be able to retain a larger percentage of its income than an equivalent number of dispersed sites, thus resulting in a higher income multiplier.

A major ramification of siting an IFSC in an isolated rural region is the industrial growth it might stimulate. Gerald Garvey, a leading proponent of using energy centers to revitalize stagnant hinterland regions, maintains that centers would provide the focal point for substantial regional growth in a manner that dispersed sites could never hope to achieve either individually or collectively. According to this scenario, new industry would be encouraged to locate in the general vicinity of the nuclear facility. In so doing, the impact community could not only diversify its economic base but could also establish a more sustainable need for permanent services and living quarters and thereby help ensure its future (General Electric, 1975: II). The addition of employers and residents to the community who are not dependent upon the IFSC for their livelihood should help counteract what could otherwise be strong tendencies in the direction of a "company town.". Whether enough prerequisites would be present for other industry to locate near an IFSC is unknown. Certainly the potential advantages and disadvantages of such a regional "growth pole" scenario justify further research.

A benefit of indeterminate amount to the general region near an IFSC would be in the building materials and equipment the region could provide for the construction and maintenance of the IFSC. While the total IFSC cost has not been established, even a relatively small percentage of the obviously high total cost could have a significant impact on local businesses.

It is evident that the siting of an IFSC could have important economic ramifications. The impacts appear to be greater than those for an equivalent number of dispersed reactors or non-power-generating fuel cycle facilities, at least in the case of isolated rural IFSC sites. Considerable generic and site-specific research is needed, however, to better understand the economic consequences that could transpire from the different siting scenarios.

Aesthetic and Archaeological Impacts

Because aesthetic and archaeological issues are highly site-specific, a detailed assessment is impossible in this paper. It is apparent that any large power-generating IFSC would constitute a very visible entity for anyone within view. However, it is quite foreseeable that the aesthetic intrusions represented by one IFSC, while possibly severe, would not be as adverse as those on similar landscapes made by as many as ten dispersed generating facilities and/or several additional non-power-generating facilities. As demonstrated by the licensing problems associated with the Montague, Massachusetts, and Greene County, New York, nuclear power plants (U.S. Nuclear Regulatory Commission, 1977 and 1978), aesthetic considerations have become increasingly important in siting decisions. Because of the reduced size and absence of cooling towers and associated plumes, the aesthetic impacts of non-power-generating IFSCs should be far less than those that produce power.

From an archaeological standpoint, the utilization of well over 30 square miles of land, ample portions of which must be flat and all of which must be located near a large river or other body of water, would greatly increase the chances of archaeological finds. The same attributes of an area which would make it attractive, in part, for an IFSC would also make it attractive for the ancestors of modern man. Whether the chances for significant discoveries are relatively greater for an IFSC than for an equivalent number of dispersed facilities is impossible to say. It would certainly seem justified to retain, at least on a standby basis, a qualified local archaeologist to monitor the construction process and be available in the event that his professional services are needed. The modest costs involved combined with the potential for significant finds would justify such an approach at an IFSC.

Conclusion

This paper has presented a comparison of the potential socioeconomic impacts of colocated vs dispersed nuclear facilities. An essential but unavoidable qualification of this study is its assumption that all dispersed sites are similar to the single site of the IFSC. In making these comparisons, due consideration was given to such important distinctions as whether the colocated facility did or did not generate electricity, the size of the colocated facility, the location of the facility, and the construction time schedule.

The comparison has revealed that certain advantages would probably accrue to the colocated facility in the sense that its overall community impacts, while obviously far greater than those of a single dispersed facility, would probably be less than the collective impacts of an equivalent number of dispersed facilities at similar locations. Specific IFSC advantages appear to exist regarding such matters as the extent of the region impacted, the provision and funding of public services, growth management, social and political cohesiveness, aesthetic and archaeological considerations, and possibly some pollution issues. In respect to several important economic factors, evidence indicates that IFSCs might have greater impacts than would an equivalent number of dispersed sites, but that such impacts would be positive in an employment and economic development sense.

On the other hand, the magnitude of an IFSC would have the potential to create very significant impacts upon the tax structure of not only local communities but an entire state. The result could be major revisions of the tax codes of states hosting IFSCs. The IFSC may also create the impetus for new restrictive legislation relative to siting regulations, development policies, antitrust laws, effluent releases, nuclear waste storage, and federal-state relations.

An important conclusion of this assessment is that many of the adverse socioeconomic impacts which could transpire from an IFSC could be mitigated significantly at the outset by siting the facility within commuting distance of sizable urban centers. Such a siting policy would also hold true for two-unit LWRs but would be particularly vital for IFSCs. Another significant conclusion is that proper phasing of reactor construction, which is not a major factor with two-unit plants, would make impacts more manageable by lengthening the construction period possibly even into a virtually levelized and permanent process better suited to community development.

The major difficulty posed by an IFSC would probably be its mammoth size. Although a number of socioeconomic advantages would result from this fact relative to dispersed sites, the possibility exists that public perception of these advantages would be obscured by the massiveness that had created those advantages. If current trends in licensing disputes and public controversies over nuclear and environmental issues serve as useful guides to the future, the prospects for IFSCs are not bright regardless of any projected benefits. Sheer size, along with the national and conceivably even international importance given to such a facility, could create a degree of visibility and hence controversy which could well preclude its development.

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